DOCUMENT RESUME

ED 041 047 TM 000 015

AUTHOR Follman, John; and Others
TITLE Discriminant Analysis of Scholastic Aptitude and Critical Thinking Tests and Levels of "Disadvantagement."
PUB DATE Mar 70
NOTE 9p.; Paper presented at the joint annual meeting of the American Educational Research Association and the National Council on Measurement in Education, Minneapolis, Minnesota, March, 1970

EDRS PRICE EDRS Price MF-$0.25 HC-$0.55
DESCRIPTORS *Academic Aptitude, *Critical Thinking, *Disadvantaged Youth, Discriminant Analysis, *Evaluation Techniques, *Thought Processes

ABSTRACT

Differences among school children are typically measured by achievement, aptitude and/or intelligence tests. This study investigates the use of critical thinking tests to differentiate between schools of varying racial, economic, and "disadvantagement" factors; the latter being determined by Title I ESEA qualifications and U. S. Office of Education racial mix data. The Watson-Glaser Critical Thinking Appraisal Form ZM and the Cornell Critical Thinking Test Form X were administered to ninth grade students in twelve schools: Four Negro (N=249), four integrated (N=283) and four white (N=279). Discriminant function analysis of the subtest scores revealed significant differences between the three groups. Analysis of variance also yielded a significant contrast among group means. The results suggest that critical thinking tests, like achievement tests, are useful for determination of educational strengths and weaknesses. (Author/PR)

ED041047

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Discriminant Analysis of Scholastic Aptitude and Critical Thinking Tests and Levels of "Disadvantagement"

William Miller
Univ. of South Florida

John Follman
Univ. of South Florida

David E. Hernandez
Florida Tech. Univ.

ABSTRACT

The Watson-Glaser Critical Thinking Appraisal: Form ZM and the Cornell Critical Thinking Test: Form X were administered to children in twelve schools. Four schools were integrated, four were Negro, and four were white. Discriminant analysis of the scores obtained on nine subtests of the critical thinking tests yielded significant discrimination among the three groups of school children. All subtests yielded significant ANOVA results for contrasts among the group means. The results suggest that critical thinking tests, like achievement tests, are useful for determination of educational strengths and weaknesses.

INTRODUCTION

Differences which exist among school children are typically measured by achievement, aptitude and/or intelligence tests. Recent research has been concerned with tests of critical thinking for academic use. Follman and Hernandez (1968) examined relationships between scholastic aptitude and/or achievement tests and critical thinking tests and "disadvantagement" of ninth graders. In a factor analysis of this data Follman, Miller and Hernandez (in press) identified an achievement scholastic aptitude subtests factor. A Watson-Glaser critical thinking test factor, and a Cornell critical thinking

TM 000 015

test factor. In another study Follman (1969) correlated critical thinking and English tests and found the English test to correlate as highly with the three critical thinking tests as they intercorrelated, indicating the strong influence of English variance on critical thinking. Little research has been concerned with the use of critical thinking tests for the differentiation of levels of "disadvantagement."

The purpose of this study was to assess the efficacy of two tests of critical thinking to differentiate between schools which varied with respect to the degree to which children within them were racially integrated and inferentially "disadvantaged." Two tests were employed, the Watson-Glaser Critical Thinking Appraisal Form ZM (Form ZM) and the Cornell Critical Thinking Test Form X (Form X). Form ZM consists of five subtests: Inference: Recognition of Assumptions; Deduction; Interpretation; and Evaluation of Arguments. Form X consists of four subtests: Induction; Reliability; Deduction; and Assumptions. These nine subtests constituted the test battery for the discriminant analysis.

PROCEDURE

The ninth grade sample was drawn from twelve schools in Hillsborough County, Florida. Four schools contained all Negro students and were regarded as "disadvantaged" (Group I). Four schools contained both white and Negro children considered to be "disadvantaged" (Group II), and four schools contained all white students considered to be "non-disadvantaged" (Group III). The criteria for "disadvantagement" were the schools' qualifications for Title I of the Elementary and Secondary Education Act, and the U.S. Office of Education racial mix data. Sample sizes were 249, 283, and 279 respectively.

Discriminant function analysis (Cooley and Lohnes, 1962) was used to determine if statistically significant differences existed among these three groups with respect to scores on the critical thinking subtests. The following analyses were conducted: simple ANOVA for each of the nine subtests; F test for the subtest differences of the centroids in the hyperspace of the nine dimensions; and coefficients of discriminant functions associated with the roots of the product matrix formed from the inverse of the within group sums of squares and the among group sums of squares matrices (it is these linear discriminant functions which maximize the distance among centroids of the groups in a discriminant space, a space usually of much smaller dimension than the original).

RESULTS

Table 1 presents the total intercorrelation matrix, means, and standard deviations of the nine subtests of the two critical thinking tests for the total sample. Table 2 presents the means, standard deviations, and simple ANOVA for each of the three school groupings for Form ZM and Form X for the total sample. Intercorrelation matrices for each of the groups are not presented for the sake of brevity. In general, the group intercorrelation matrices compare highly with the total matrix and with each other. The within tests intercorrelations were higher than the between tests intercorrelations in each matrix. Table 3 presents the eigenroots, eigenvectors, scaled vectors and the F statistic associated with the Wilkes Lambda statistic. While no roots obtained a value of 1.0 or higher, the F statistic indicated significant discrimination. The first root accounted for 91% of the product matrix variance as reflected in the trace. Hence a single

dimension appears adequate to differentiate the three groups. Using this resulting function, a given pupil could be classified into one of the three schools based on his "resemblance" to others on the discriminant score variable. Of course, in practice, this pupil's score only provides us with a statement of the probability of having been a sampled member of the groups for which scores were derived and it is possible that the pupil does not really "fit" any of the sampled groups well. Since the authors were not focally concerned with classifying unknown individuals into three groups, but rather in determining whether the groups were discernible, individual classification probabilities were not computed.

DISCUSSION

The results indicate that schools of varying racial and economic and inferentially "disadvantagement" factors are differentiable on the basis of critical thinking tests. This finding is not surprising in view of the finding of Follman, Miller and Hernandez (in press) of a moderately high relation between scholastic aptitude, achievement, and critical thinking subtests. Other studies (Coleman, et al., 1966; Follman, et al., in press; Jensen, 1969) have shown that children from "disadvantaged" backgrounds have poorer academic achievement records than other children. These findings have been so consistent that they contributed to the passage of legislative acts such as Title I of the Elementary and Secondary Education Act of 1965. It therefore follows that subtests such as critical thinking subtests that correlate significantly with achievement tests would also differentiate children of varying "disadvantagement." A question not answered by this study, however, is what <u>unique</u> contribution critical

thinking tests make in identifying sources of variation in academic achievement of pupils. A related question is one of "sensitivity" of one measurement device to an artificial criterion like "disadvantagement." Do critical thinking tests provide a better predictor of "cultural disadvantagement," i.e., differentiate to a more precise degree the variations found in pupil school performance attributable to socio-economic factors? Of course, if socio-economic "disadvantagement" is a major determinant of school achievement then any instrument correlated with school achievement will "differentiate" along socio-economic lines and prove nothing. What is ultimately of concern is to determine the degree to which cultural influences may be diminished by differentiated academic programs and what measures can identify those amenable to these instructional programs.

TABLE 1

Intercorrelations of Critical Thinking Subtests

of Form ZM and Form X (N=811)

	1	2	3	4	5	6	7	8	9
1	1.00								
2	.59	1.00							
3	.53	.66	1.00						
4	.60	.63	.74	1.00					
5	.56	.52	.61	.71	1.00				
6	.54	.36	.33	.41	.39	1.00			
7	.30	.35	.38	.39	.32	.64	1.00		
8	.38	.37	.41	.42	.35	.63	.68	1.00	
9	.32	.29	.37	.38	.33	.51	.59	.68	1.00
$\overline{X}$	6.73	8.55	13.13	12.28	7.09	11.71	8.94	6.79	3.39
S.D.	4.19	3.94	5.25	5.43	3.60	6.17	4.48	4.23	2.47

TABLE 2

Means, Standard Deviations, and ANOVA of Three Groups on

Critical Thinking Subtests

Group		Watson-Glaser Form ZM					Cornell Form X			
		1	2	3	4	5	6	7	8	9
I	$\overline{X}$	5.54	7.90	12.18	10.88	6.26	10.11	7.49	5.27	2.52
	S.D.	2.87	3.63	4.67	5.07	3.65	5.42	3.95	3.74	2.10
II	$\overline{X}$	6.43	8.43	12.53	11.89	7.00	11.79	9.07	6.80	3.33
	S.D.	3.59	3.92	5.31	5.13	3.41	5.83	4.48	4.25	2.36
III	$\overline{X}$	8.11	9.25	14.59	13.94	7.91	13.07	10.09	8.13	4.24
	S.D.	5.24	4.13	5.39	5.63	3.58	6.78	4.59	4.17	2.61
	Among Mean Square	454.08	122.31	459.49	650.15	180.40	577.30	448.52	537.78	195.91
	Within Mean Square	16.50	15.30	26.59	28.02	12.59	36.74	19.09	16.64	5.66
	F-Ratio	27.51	7.99	17.27	23.20	14.32	15.71	23.49	32.31	34.59

df: $n_1 = 2$, $n_2 = 808$

TABLE 3

Eigenroots and Associated Vectors of the W^{-1}_{x} A Matrix

	1	2
Roots	.14	.01
Percent of Trace	91.00	9.00
	Vectors	
1	.55	.21
2	-.29	-.33
3	-.01	.65
4	.19	.08
5	-.04	-.45
6	-.20	-.02
7	.20	-.36
8	.26	-.19
9	.64	.16
	Scaled Vectors	
1	64.05	25.17
2	-32.35	-36.80
3	- 2.59	95.76
4	28.63	13.12
5	- 4.91	-46.06
6	-35.63	- 4.96
7	25.09	-45.42
8	30.47	-22.61
9	43.63	11.19

Wilkes Lambda = .86 $\quad F^{18}_{1600} = 6.85$

REFERENCES

Cooley, W. and Lohnes, P. Multivariate Procedures for the Behavioral Sciences. John Wiley and Sons, Inc., New York, 1962.

Coleman, J. S., et al. Equality of Educational Opportunity. U.S. Department of Health, Education and Welfare, 1966.

Follman, J., and Hernandez, D. An Investigation of the Effects of Four Critical Thinking Procedures on "Culturally Disadvantaged" Ninth Graders. Florida Journal of Educational Research, 9, 1968, 45-55.

Follman, J. A Factor Analytic Study of Three Critical Thinking Tests, One English Test, and One Logical Reasoning Test. Unpublished Ph.D. Dissertation, Indiana University, 1969.

Follman, J., Miller, W., and Hernandez, D. Factor Analysis of Achievement, Scholastic Aptitude, and Critical Thinking Subtests. The Journal of Experimental Education (in press).

Jensen, A. R. How Much Can We Boost IQ and Scholastic Achievement? Harvard Educational Review, 39, 1969, 1-123.